Preliminary Results of Noise Monitoring in 1995 in Bryce Canyon National Park

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Abstract: Staff at Bryce Canyon National Park conducted noise monitoring surveys from 30 May to 31 August 1995 at five sites using the 15-second Leq method. Noise levels from helicopters, planes, jets, and other mechanical means, as well as natural or background noise were monitored. Aircraft were heard park-wide an average 18.8% of the time with an average of 36.4 decibels. Site-specific information is presented on peak decibel levels, average noise levels, and number of aircraft overflights.

Key words: Aircraft, monitoring, noise, overflight.

Visitation to Bryce Canyon National Park by the general public continues to increase on a yearly basis. Impacts from visitation are coming in a variety of ways, but park management has become increasingly aware that noise from mechanical sources, particularly aircraft, has the potential to undermine the natural quiet for which the park has been noted.

Use of aircraft to travel to, and view Bryce Canyon National Park has been possible almost from the park's inception. Even before the park was created in the early 1920s, a U.S. Forest Service plan for development included location of a suitable site for "Aeroplane landing" (Scrattish 1985). By the mid-1930s the development of an airport just two miles north of the park was underway. An emergency landing strip with a hangar was completed by 1937 under the combined efforts of the Work Projects Administration, Civilian Conservation Corps, and Garfield County (G. Pollock, Bryce Canyon Airport, personal communication).

In 1977, a private corporation, based immediately north of the park, began offering helicopter and fixed wing tours of the park and region (P. Cox, Bryce Canyon, Utah, personal communication).

In 1995, park staff began a program to monitor noise levels throughout the park. Purposes of the study were to aid in the establishment of baseline data on natural quiet and noise source types within the park, the percent of time these are heard, and the noise equivalent levels (Leq) in decibels.

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Methods

The project was coordinated by the Division of Resource Management aff at Bryce Canyon National Park. Surveyors were volunteers and park aff.

Five sites were established for monitoring noise from low to high levation and included canyon rim and back country locations (Fig. 1). The sites were adjacent to the escarpment of the Paunsaugunt Plateau, which consists of a series of geologic formations eroded into vertical structures known in geologic terms as "hoodoos." This is also the major feature of interest for park visitors, as it dominates the area and provides vistas of exceptional quality to the surrounding areas. The Fairyland site (UTM: 400173E, 4165835N), was adjacent to the Fairyland Loop Trail, underneath the escarpment or rim, on a ridge sparsely vegetated with ponderosa pine (*Pinus ponderosa*) and a scattered assortment of manzanita (*Arctostaphylos patula*) and grasses, at an elevation of 7,480 feet. The Water Tanks site (UTM: 396731E, 4163898N), was adjacent to the Rim Trail mid-way between the Sunset Point and Inspiration Point overlooks, on the top of the rim, with a heavy vegetative cover of ponderosa and manzanita, at 8120 feet elevation. The Swamp Canyon site (UTM: 393172E, 4159728N), was adjacent to the Swamp Canyon and Sheep Creek trails, beneath the rim, with a heavy vegetative cover of ponderosa, manzanita, and Gambel oak (*Quercus gambelii*), at an elevation of 7,720 feet. The site in Agua Canyon (UTM: 389033E, 4152198N), on the Agua Canyon Connecting Trail switchbacks below the rim, was at an elevation of 8,560 feet, in an amphitheater with a sparse vegetative cover of bristlecone pine (*Pinus longaeva*). The last site, Bristlecone (UTM: 390761E, 4147658N), was on the Bristlecone Loop Trail, at 9,040 feet elevation, surrounded by bristlecone pine, Engelmann spruce (*Picea engelmannii*), white fir (*Abies concolor*), and Douglas fir (*Pseudotsuga menziesii*).

Equipment and training were obtained from the Washington Office of the National Park Service. Equipment protocols, monitoring procedures, and spreadsheet analysis were derived from "Selecting a Simplified Method for Acoustic Sampling of Aircraft and Background Sound Levels in National Parks" (Miller et al. 1995). The equipment used was a tripod-mounted CEL 269 Sound Level Meter with wind screen and CEL 282 calibrator. The monitor provided measurement of sound levels from 30 to 100 decibels. This equipment is easy to use because there are few steps for setup and operation. Before and after calibrations provided efficient means to ensure proper equipment function. A digital readout wind meter was also used to determine wind speed.

The procedure used has been described as the 15-second Leq method. A log sheet was used to annotate the noise "equivalent" level (Leq) in decibels for every 15 seconds over a 1 hour time period. The Leq was coded as the

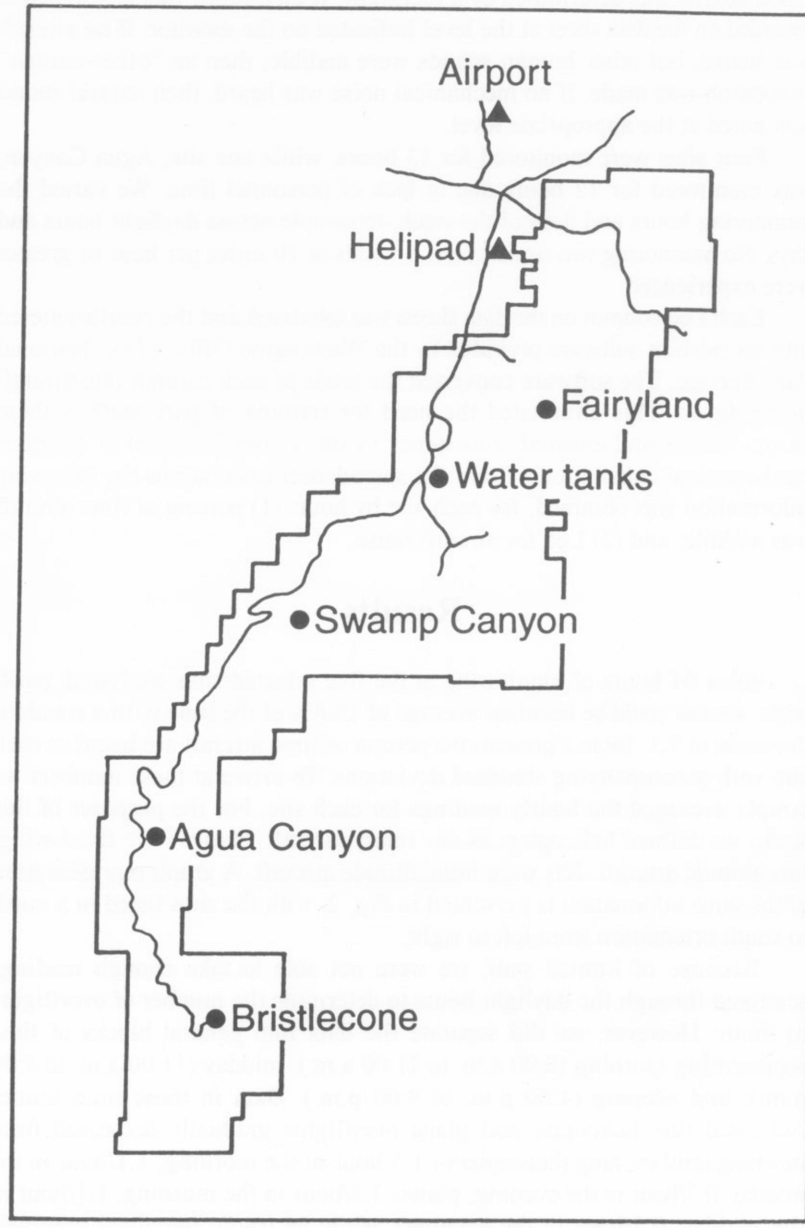

Fig. 1. Bryce Canyon National Park boundary, noise monitoring sites, and aircraft landing locations.

sound source the observer heard at the end of each 15-second time period. The sound source was determined by a hierarchy. If an aircraft was heard, it was recorded on the data sheet at the level indicated on the monitor. If no aircraft was heard, but other human sounds were audible, then an "other-human" annotation was made. If no mechanical noise was heard, then natural sound was noted at the appropriate level.

Four sites were monitored for 13 hours, while one site, Agua Canyon, was monitored for 12 hours due to lack of personnel time. We varied the monitoring hours and days of the week, to sample across daylight hours and days. No monitoring was undertaken if winds of 10 miles per hour or greater were experienced.

Each Leq column on the data sheets was tabulated and the results entered into spreadsheet software provided by the Washington Office of the National Park Service. The software converted the totals of each column into aircraft noise doses. This eliminated the need for training of park staff in these computations and ensured consistency in the accomplishment of complex mathematical calculations. From the spreadsheet calculations the following information was obtained, for each site by hour: (1) percent of time aircraft was audible; and (2) Leq for aircraft noise.

Results

After 64 hours of monitoring at the five selected sites we found, park-wide, aircraft could be heard an average of 18.8% of the time with a standard deviation of 7.3. Table 1 presents the percent of time aircraft are heard at each site with accompanying standard deviations. To arrive at these numbers we simply averaged the hourly readings for each site. For the purposes of this study, we defined helicopters as any rotary aircraft. Planes were fixed-wing, low altitude aircraft. Jets were high altitude aircraft. A graph representation of the same information is presented in Fig. 2, with the sites listed in a north to south orientation from left to right.

Because of limited staff, we were not able to take enough readings scattered through the daylight hours to determine the number of overflights by hour. However, we did separate the data into general blocks of time representing morning (6:00 a.m. to 11:00 a.m.), midday (11:00 a.m. to 4:00 p.m.), and evening (4:00 p.m. to 9:00 p.m.). Data in these time frames indicated that helicopter and plane overflights gradually decreased from morning until evening (helicopters - 1.5/hour in the morning, 1.1/hour in the midday, 0.7/hour in the evening; planes 1.3/hour in the morning, 1.1/hour in the midday, 0.3/hour in the evening), while jet traffic remained relatively constant throughout the day (4.9 in the morning, 4.1 in the midday, 5.8 in the evening).

Table 1. Percent of time aircraft heard at monitoring sites. Numbers in parentheses are the standard deviations for the decibel levels.

	Fairyland	Water Tanks	Swamp Canyon	Agua Canyon	Bristlecone
Combined aircraft	29.2 (18.8)	19.3 (15.3)	21.8 (9.9)	12.4 (7.2)	11.4 (6.5)
Jet	13.1 (14.2)	11.9 (8.6)	13.4 (8.0)	8.6 (5.6)	9.9 (5.6)
Helicopter	11.5 (11.9)	3.5 (4.7)	5.5 (7.1)	2.7 (5.8)	1.0 (3.5)
Plane	4.2 (3.4)	3.8 (3.7)	3.1 (3.3)	1.2 (1.5)	0.6 (2.1)

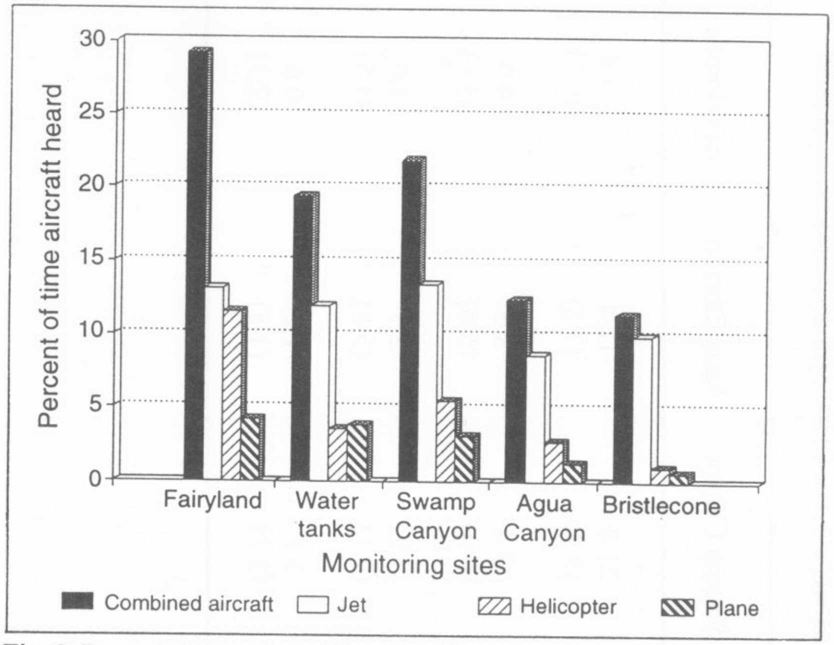

Fig. 2. Percent of time aircraft heard at monitoring sites.

Peak decibel levels recorded from the meter at each site by aircraft type were Fairyland (jets - 58, planes - 59, helicopters - 70); Water Tanks (jets - 58, planes - 56, helicopters - 53); Swamp Canyon (jets - 56, planes - 57, helicopters - 62); Aqua Canyon (jets - 61, planes - 54, helicopters - 70); and Bristlecone (jets - 58, planes - 56, helicopters - 51).

Discussion

In a north-south orientation of the sites, it was evident that the sites in the north experience greater amounts of noise from aircraft overflight. These sites were not only closer to the airport and helicopter pad, but were lower in elevation and also lie closer to flight patterns for optimal viewing of the main amphitheater and geologic formations of the park.

One phenomenon we noticed was the level of noise experienced by the observer changed with respect to the position of the aircraft engines or rotor. For example, high altitude jets were rarely heard until directly overhead, but were heard for long time periods after passing. The same is true for planes, with the exception that they were more easily perceived on approach to the observer, because of lower flight altitudes. Helicopters, on the other hand, were heard for tremendous approach and retreating distances, depending on the position of the observer with respect to the helicopter rotors. For example, the peak decibel level recorded for helicopters (70 decibels) was at both Fairyland and Agua Canyon. These sites were both below the normal flight altitude of all aircraft. Fairyland is within close proximity to helicopter tour operation flight patterns. In comparison, the Bristlecone and Water Tanks sites, both located above the rim at elevations above or horizontal to normal helicopter flight altitudes had peak readings of 51 and 53 decibels, with only Water Tanks being in close proximity to normal tour operations. If the observer was below the level of the rotor, the noise levels were much higher than if horizontal to or above. Gradual decreases in overflights of helicopters and planes from morning to evening may result from geographic orientation of the park. With the escarpment exposed to the east, greater viewing may be obtained earlier in the day from the air.

There are many factors affecting the sound levels from aircraft. Some of these include: (1) aircraft height; (2) slant distance of the aircraft to the observer; (3) atmospheric absorption and aircraft source spectra; (4) attenuation due to intervening hills and heavily wooded areas; (5) attenuation of ground or ground cover that softens noise levels such as grassland; and (6) how the sound of the aircraft is defined, such as total sound exposure, duration, or the maximum sound (Anderson and Horonjeff 1992).

Because the equipment used for this study would not measure noise below 30 decibels we were constrained to research other studies to detect ambient or background noise levels. During the late 1970s, monitoring of noise levels within the park was conducted in conjunction with a proposed open pit coal mine near the park. During the day, in absence of strong winds, ambient sound levels frequently fell below 20 decibels. This is comparable to sound levels experienced in high quality recording studios (Foch and Oliver 1980).

The vast majority of helicopter overflights in the park are from the private tour operator located just outside the park to the north. This service provides visitors a unique view of the park and the geology not obtainable from the ground. Of the complaints received at the park, the most common are consistently concerned with helicopter noise and overflight. These complaints generally come from visitors who have made an effort to seek the solitude and quiet of back country areas. Although this study shows that helicopter overflights create a deterioration of natural quiet for the time they are heard, a significant amount of the aircraft noise heard is generated by jet and plane traffic. Jet and plane traffic may be "tuned out" by the general public and accepted as part of the normal spectrum of noise, as few complaints concerning these are received. It is also of interest to note that the areas where the solitude experiences are probably best experienced are the areas where the helicopter overflight percentages and noise levels are the least.

The fixed-wing overflights are from two primary sources. The first source is scenic and sightseeing flights bringing visitors to the airport. These include single- and twin-engine aircraft with a capacity of a few to about 20 passengers. The second group is private aircraft flying to the area. In the fall of 1995, the Federal Aviation Administration changed the Bryce Canyon Airport designation from general aviation to commercial due to increased use of the airport facilities. As of mid-November 1995, it was estimated that 1,200 aircraft had landed at the airport during the year. Use of the airport is projected to increase at an annual rate of 12 to 15%, from both scenic tours and private aircraft, based on recent trends (G. Pollock, Bryce Canyon Airport, personal communication). Although there have been, and are now, many users for the airstrip at Bryce Canyon, the original designation was for an emergency landing strip for commercial aircraft. The park and surrounding area lie under some of the busiest commercial air traffic flyways in the country. These include, but are not limited to: (1) Las Vegas, Nevada to Denver, Colorado; (2) Salt Lake City, Utah to Phoenix, Arizona; (3) San Francisco, California to Denver, Colorado; and (4) Los Angeles, California to Denver, Colorado. This understanding provides a more complete picture as to the levels of noise experienced in the park by commercial jets.

This research provides a better understanding of the types of noise occurring in the park, including the amount of time non-natural noise occurs. It will help establish baseline data to aid park managers in working to mitigate the degradation of "natural quiet" within the park and surrounding area. The potential increase in aircraft traffic may have serious impacts to this valuable natural resource.

Acknowledgments

We thank W. Henry of the Washington Office of the National Park Service for equipment loan, training and technical support throughout the study.

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